LIMNOLOGICAL INVESTIGATIONS AT FLATHEAD LAKE, MONTANA, AND VICINITY, JULY, 1899

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WITH NINE PLATES

The University of Montana Biological Station was organized in the summer of 1899, and consequently but one season's work has been done. The organization of the work was made possible through contributions from friends in the state, contributions being made from individuals in Missoula, Kalispel, Butte, and other places.

The object of the station is twofold: (1) to offer a place where biological investigations may be pursued during the summer months, where the collecting season is short and concentrated, and to encourage students in their work, to offer them facilities, and to bring biological study to a higher plane in the schools; (2) to pursue systematic work along definite lines with a view of working out some scientific problems, to make collections for the University work and for the museum, and to work up the natural history resources of the state.

The plan for the work was presented to the State Board of Education, which heartily approved of it. The station was placed on the same basis as a department of the University, and so far as possible appropriation was made for its maintenance. The work of the first year was preliminary, most of the time being spent in laborious detail work, in fixing up a laboratory, looking after boats, seeking collecting sites, and in similar duties. Nevertheless, a dozen workers were gathered together, much good material was collected, and a good beginning made.

The station facilities are not large, but present ample opportunity for work as a beginning. A small field laboratory has been erected, with tables for twelve students, a dark room for photography, and a store room. The boats consist of a gasoline launch capable of carrying eight people, a row boat,

and a canvass boat for use in mountain lakes and in remote regions where a boat must be transported. Microscopes, glassware, chemicals, books, and all necessary materials are taken to the field laboratory from the University. Nets after Kofoid's plans, and also a pump for plankton, after plans by Ward, have been made. Apparatus for taking fish and insects, cameras, firearms, etc., are provided. The boats and equipment referred to can be seen in Plates XVI and XVII.

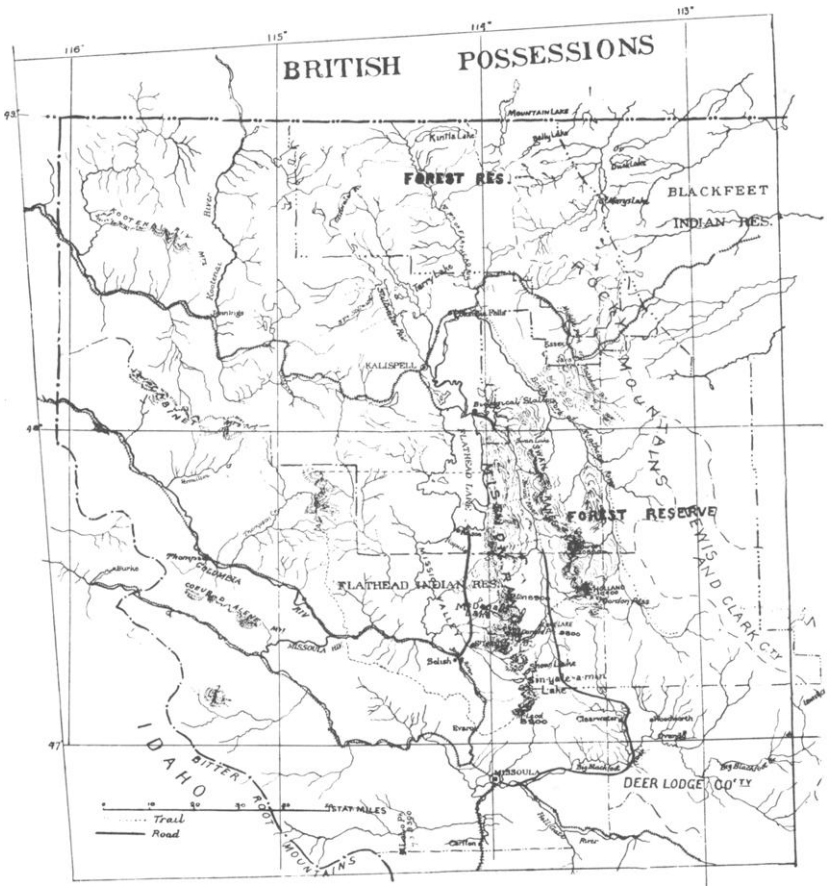
During the first season very little work could be done on Flathead Lake. A number of soundings were made, and at each sounding the net was let to the bottom and hauled to the surface. Although this method was unsatisfactory, yet the results are very interesting. Surface hauls were made on several occasions. In addition to this work on Flathead Lake considerable time was given to Daphnia Pond, near the laboratory, and described later. A day was spent at McDonald Lake in the Mission Mountains.

Very little work has been done in the region, or in Alpine lakes in general in this section. Ichthyological work was carried on by Dr. David S. Jordan in the Yellowstone National Park, in 1889, and by Prof. W. B. Evermann, in Montana and Wyoming, in 1891. In 1890, Prof. Edwin Linton, of Washington and Jefferson College, Pennsylvania, and Dr. S. A. Forbes, of the University of Illinois, together made extensive study of the life of the waters of the Yellowstone National Park, the former having in hand the study of fish parasites, the latter of fresh water invertebrates. In 1891, Dr. Forbes and Prof. Everman spent some time in the region around and adjacent to Flathead Lake; the former again looking after fresh water invertebrates, the latter collecting fishes and seeking a suitable place for a trout hatchery. The results of Dr. Forbes' work are given in a paper of 52 pages, with six plates, in the Bulletin of the United States Fish Commission, Vol. XI, pp. 207-258. The work of these men is all that has been done on the life of these lakes, so far as is known to the writer.

The map (Plate IX)* will give an idea of the general

* Map showing the section of the state north of Missoula to the boundary line, and from the main chain of the Rocky Mountains west to the Idaho boundary line. Only a few of the smaller lakes are included. The rivers and streams are not accurately drawn, but are to the best of our present knowledge. Few of the mountain ranges are indicated. Each water course is a canyon, usually narrow, between two ranges of hills or mountains. Few wagon roads have been made through the canyons, but of those existing only two or three are located. Most of the streams, many of the lakes, and all of the peaks are inaccessible except on foot or by pack train.

PLATE IX


BRITISH POSSESSIONS
FOREST RES.
BLACKFEET INDIAN RES.
KALISPELL
FLATHEAD INDIAN RES.
FOREST RESERVE
DEER LODGE CO'TY
IDAHO
BITTER ROOT MOUNTAINS
Trail
Road

outline and shape of Flathead Lake, the streams flowing into the lake, the outlet, routes of travel, and other points of information. A brief description of the lake, with its geological history, will be of importance in taking up the study of the life found. The geological description here given is furnished by Prof. Fred D. Smith, of the University of Montana. (Cf. Plates X, XI, XII.)

"The lake occupies the lowest portion of an immense valley that reaches from the Jocko Mountains, a low range between the Jocko River and Mission Valley, northward across the British Columbia line into the latter country, a distance of over one hundred miles. It is but the remnant of a lake that in Tertiary times occupied this valley throughout its whole extent. The great level plains on either end of the lake are the beds of sediment deposited in the former lake, and show by the character of their soils that the lake was a large and quiet body of water. The plain on the southern end of the present lake is about thirty-five miles long. On the northern end of the lake the plain extends a distance of sixty miles to the border of the United States and into the British possessions.

"The valley, as well as the lake throughout much of its length, is bordered on the eastern side by the Mission Mountains, a range which rises abruptly from the plain to a height of 10,000 ft. These mountains, with a very steep western slope, have their summits within relatively short distances from the valley, and consequently the streams therefrom are not large nor of great volume in discharge. The peaks of the range rise bare and steep. The range appears to terminate as such at a point near the upper end of the lake where the Swan or Big Fork River changes its course from northward to west and southwestward, to flow into Flathead Lake.

"Mission Valley, Flathead Lake, and Flathead Valley extend about a hundred miles from north to south; Flathead Lake separating Mission Valley on the south and Flathead Valley on the north. Perhaps the most interesting feature of the region represented is its drainage. The drainage from Flathead Valley is through the Flathead River. This has three great tributaries, the South, Middle, and North Forks. The latter, only, is a real factor in the drainage of the valley. The Flathead River flows into Flathead Lake from the north, as does also the Swan River. These together materially in-

crease the size of the lake in the spring time. The outlet of the lake is the Pend d'Oreille River, also called Flathead, which flows out of the lake at the southern extremity. Following a circuitous route in a south-westerly direction, it receives the streams that cross the southern portion of the valley transversely, and eventually unites with the Missoula River to form Clarke's Fork of the Columbia. Considered thus, Flathead Lake appears as an enlargement of Flathead River, and as one element in the drainage system.

"The Mission Mountains were made by an immense fault, having the general direction of north by south. The mountains were raised, while the corresponding strata on the western edge of the fault were depressed, thus producing the usual basin for the immense lake which afterwards filled it. Possibly the lake was not a part of a drainage system, as the present lake is, but acted as a large reservoir. When the lake was drained, probably through a passage to the north,* there was no large amount of run-off from any extensive drainage system to be carried away. The small streams that came from the lower part of the Mission Mountains cut small water courses directly across the beds to the west in parallel directions. Flathead Lake receded to the lowest parts of the depression in the great valley, which were approximately the central portions. The lake may have occupied different levels in its present position, though it has probably never been high enough to receive any of the drainage of the lower Mission Mountains, owing to a larger embankment along its southern end. This ridge may be of morainal origin, and probably was, since it is higher than the surrounding plains on either side, and no evidence has been observed of higher levels of the sedimentary lakes.

"When in its new position the lake, receiving considerable inflow from the north, began to find an outlet across the beds in a southwesterly direction towards the Missoula River. Whether this was caused by a damming of the streams on the north by glaciers or by elevation of the country is not plain at present. The carving of what is now the Pend d'Oreille River canyon probably was rapid, and the lower plains on the north of the present lake were uncovered, thus making the fertile areas south of the city of Kalispel. The

* Later research indicates that the passage was out of the western bay, possibly near Dayton.

Flathead River in its present condition is but a remnant of the lake which extended over these areas.

"This Flathead River winds its way in a very circuitous path across the plains, and has a total length of about thirty-five miles, while the distance as measured by a straight line is but fifteen miles. In general its width is from three hundred to six hundred feet, and its depth is over twenty feet in all places, and often reaches seventy-five feet. For these reasons it may be considered but an arm of the lake, since its level is the level of the lake except for sufficient fall to cause the waters of the tributaries to flow to the lake. On account of the very sluggish nature of the current of this river the erosion of the banks is slight, while the deposition in the bottom and at the mouth of the river is rapid.

"The northern end of the lake around the mouth of the river is apparently composed of sediments deposited as a large delta in the manner mentioned. The course of the river is plainly traced into the lake for some distance by the delta thus formed, which for a distance of from one-fourth to one-half a mile from the shore is sufficiently high to be covered by vegetation, and in some places by shrubbery. Beneath the surface of the water the formation is discernible for a long distance farther into the lake.

"At the end of the Swan River Valley near the location of the Biological Station are to be seen many rounded hills which are probably morainal in origin. On the slopes of the Mission Mountains that form the termination of this range are found many evidences of glacial action in form of smoothed rocks, post-glacial gorges and stream courses, glacial scratches, etc., while the glacial origin of the ridge at the foot of the lake has already been suggested. There is no doubt but that glacial agencies have materially affected the history of the lake both in its present and in its older form. To what extent moraines may affect the contour of the lake bottom can only be surmised, but as they are apparent on the beds of the older lake it is to be expected that they may be found on the bed of the present lake."

The outlet is called by some Pend d'Oreille River, by others Flathead River. Some consider Flathead River to extend from its source to the lake, then from the lake to the Missoula River. Others give the name Pend d'Oreille to the stream from Flathead Lake to the Missoula River. The river formed

by the junction of the Missoula and Pend d'Oreille is called Clarke's Fork of the Columbia.

The present outlet of Flathead Lake is of recent origin. The river for several miles near the lake is swift and rocky, a series of rapids alternating with more quiet water. About a mile from the lake there is a large bank of clay through which the river has cut. The clay is continuous with, and apparently a part of, the moraine mentioned. At the river bank it has been cut and eroded by the wind and rain. The bank is abrupt and steep, the clay clinging together so as to form cliffs, some ending in sharp pinnacles. Below the clay is the bed rock, similar to that found at different places around the lake. The river has done some cutting through the solid rock bed, but not much. At one place the channel is partially dammed by a large rock in the center of the river. Above and below this place the river is a beautiful sheet of foam, with several small falls. It is as beautiful a rapid as one usually sees. In my estimation it is superior to the rapid above the first falls in the Yellowstone. While not so large, it impressed me more deeply than did the rapids below Niagara. Several cases have been reported of people who were overcome by the sight close to the water's edge and had to be carried away. Plate XIII shows the rapids as seen from the hillside a couple of hundred feet above the water. This is a great fishing resort for the Indians on the reservation, and one seldom visits the place without seeing several tepees on the bank some place near. The osprey is as industrious as the Indian, and is seldom absent from the scene when one visits the rapids.

The banks of the lake do not afford as much shelter for invertebrate life as would at first seem apparent. The southern third, cut off by the islands, is shallow, nowhere of greater depth than twenty feet. The eastern slope of this bay, formed by the peninsula projecting from the Mission Mountains, is very marshy, with muddy bottom. Rushes and weeds grow abundantly, offering an excellent harbor for smaller life. This is the largest marshy region around the lake. Between the mouth of Flathead River and the mouth of Swan River, along the northern shore, is another marsh in the spring, of peculiar nature. At the water's edge is an embankment of a more or less rocky nature. North of this embankment is a shallow marsh, a couple of miles long and a quarter to a

half mile wide. When the lake rises, as it does in the spring, from ten to twelve feet, the water flows over the embankment, and into the low land. As the lake recedes the imprisoned waters cannot escape, and offer a fine breeding place for mosquitoes for some time, until the waters evaporate or filter through the soil to the lake again. Most of the remaining banks are rocky, precipitous at the water's edge, with or without a gravelly beach. The bottom generally is reported to be rocky, with little mud. This report comes from the captain of the boat Klondyke, who has anchored all over the lake; his experience on the lake extends over a period of many years. Compared with the size of the lake the swampy country is small. From this it would appear that the breeding grounds for most of the fish must be in regions distant from the lake, causing long migration periods. This is made more apparent from the fact that fish are rarely caught any place in the lake except at or near the streams entering the lake, or at the outlet.

Flathead Lake is popularly supposed to be very deep. I was told it was 1,500 ft. deep in places. During the summer of 1899 some twenty soundings were made in the lake and rivers. The greatest depth obtained was 280 ft. The location of this may be found by referring to the map. Eugene Hodge, captain of the Klondyke, states that nowhere is the water deeper than this sounding. During the season of 1900 other and more numerous soundings will be made.

McGovern Bay, on the northern end of the lake, is about seventy feet at the deepest. Flathead River has filled in a large amount of sediment. East of the mouth of Flathead River the drop in depth is sudden from the river bar. The deepest portion of the lake is off shore on the east side, next the Mission Mountains. In high water a great deal of land at both ends of the lake is covered. If the depth of the lake should be lessened by ten feet, thousands of acres at the lower end would be uncovered. The annual rise and fall of the lake is from ten to fourteen feet, but it has risen as much as nineteen feet in a season. The lake acts as a huge reservoir for water storage, but overflows much land almost every year when it is at the highest. The amount of water flowing into the lake and out of the lake annually has not as yet been determined.

Life in Flathead is scarce. Although some species are taken

in great abundance, the cold clear waters, with rocky bottom and banks and with few marshes, make life scarce as compared with similar bodies of water located in warmer climates at lower altitudes.

The first collecting done with the net was on July 22, the last August 11. The method employed was to let the net to the bottom and slowly bring it to the surface. This was not satisfactory, but was the best that could be done at the time. The material from each haul was placed in a vial and numbered, the data being recorded. Twenty-one numbers were taken at Flathead Lake, an additionel number at McDonald Lake. As will be seen from the data subjoined these collections were made at different parts of the lake, and represent the life of the lake at this season fairly well. It is to be regretted that material could not be taken both earlier and later in the season, but this will have to await further developments.

The record of collections and material, with data, is as follows:

No. 1. July 25, 11:00 A. M., bright sunshine. Swan River, opposite Sliter's house, near the Station. Contents, sand.

No. 2. July 25, 11:20 A. M. Mouth of Swan River opposite club house. Contents, sand.

No. 3. Bottle lost, not examined.

No. 4. July 26, A. M. Bay in front of club house, in the waters from the Swan River. Contents, nothing that could be determined.

No. 5. July 26, 10:00 A. M. Opposite first bluff below club house, where the waters from the river have become quiet; depth, 60 ft. Contents, a few *Epischura nevadensis* Lilljeborg, *Diaptomus ashlandi* Marsh quite numerous, about as many *Cyclops pulchellus* Koch, and a few *Cladocera*.

No. 6. July 26, 10:30 A. M. Between club house and mouth of Flathead River, nearly a mile from shore and perhaps a mile and a half from the river; depth, 96 feet. Contents, *Cyclops pulchellus* Koch made up the bulk of the material taken, *Diaptomus ashlandi* Marsh was rather abundant, and a few *Daphnids*.

No. 7. July 27, A. M. Flathead River, opposite Holt, which is about three miles from the mouth; depth, 56 feet. Contents, a few *Diaptomi*.

No. 8. July 27. Half mile below No. 7. A few each of *Daphnia* and *Diaptomus*.

No. 9. Mouth of Flathead River, same date; depth, 18 feet. Contents, nothing but sand.

No. 10. July 26. Lake, east of the mouth of the Flathead River; depth, 10 feet. This was in the northern shallow end of the lake, but not on the sandbar which receives the waters from the river. Contents, *Cyclops pulchellus* Koch, *Diaptomus minutus* Lilljeborg, in about equal quantities.

No. 11. Bottle lost.

No. 12. July 26. Lake, one-half mile east of club house; depth, 10 feet. Conditions similar to those in No. 10. Contents, a few *Diaptomi*, with an occasional *Daphnia thorata* Forbes.

No. 13. Lake near rocks by club house; depth, 15 feet. This is in the waters of the Swan River. Contents, a few *Cyclops pulchellus* Koch.

No. 14. Bar at the mouth of Flathead River. Contents, nothing.

No. 15. Lake between Flathead River and the club house; depth, 40 feet. Contents, *Diaptomus ashlandi* Marsh, *Cyclops pulchellus* Koch, with three or four specimens of a larger form of *Cyclops*, 2 mm. long.

No. 16. August 11. Lake about six miles below Chapman's, east side, about three miles from shore, not far from midway of the length; depth, 280 feet. *Diaptomus minutus* was found in large quantity, and *Cyclops pulchellus* Koch in somewhat smaller amount.

No. 17. August 11. Near the islands on the north, in the "channel" used by the steamboats; depth, 15 feet. Not examined for species, but no doubt similar to No. 16.

No. 18. August 11. In shallow water below or south of the islands; depth, 17 feet. Not examined for species.

No. 19. August 11. Lower end of the lake, about one mile north of the islands, opposite the point of land on the west, and the middle of the flat-topped mountain on the east; depth, 167 feet. Contents, *Cyclops pulchellus* Koch, *Diaptomus*, probably *ashlandi*, though slightly smaller, and one specimen of *Epischura nevadensis* Lilljeborg.

No. 20. August 11. Near No. 19, but at a depth of 75 feet. Contents, *Cyclops pulchellus* Koch in largest quantity, *Diaptomus* in smaller quantity.

No. 21. August 11. Several bottles of skimmings from the surface of Flathead Lake at different places. On this date

a round trip was made to the foot of the lake. At different places skimmings were taken with the net. *Cyclops pulchellus* was taken in very large quantity, and was very noticeable. While at Chapman's, on the east side, for wood, a bottle was shown him, which rather startled him when he considered he was drinking from the lake. The only comment made was that there were a good many people drinking from the lake, and he was not alone. To dip up a tin cup full of water was to take numbers of them. As the day was bright, in the middle of August, this is rather surprising, as they generally stay down during sunshine. Moreover, Forbes reported *Cyclops* as very scarce in his collecting.

No. 22. August 18. Collection made at McDonald Lake, as recorded under description of that lake.

The list taken from Flathead Lake is not large, and is as follows:

Diaptomus ashlandi Marsh.
Cyclops pulchellus Koch.
Epischura nevadensis Lilljeborg.
Diaptomus minutus Lilljeborg.
Daphnia thorata Forbes.
A few *Cladocera.*
Some young that could not be determined definitely.

Of these *Cyclops pulchellus* was exceedingly abundant, taken at nearly every point on the lake where collections were made. *Daphnia thorata* was scarce, which is surprising from the fact that Forbes relates that in his haulings with the surface net in late September, 1891, this species made probably from four-fifths to nine-tenths of each haul. He also records that *Daphnia pulex* was not seen at all, though common in Yellowstone Lake. *Daphnia pulex* was taken by thousands in Daphnia Pond, near the Station, as recorded in description of work in this pond. He also records *Epischura nevadensis*, var. *columbiae* as very common, but with us it was scarce. It therefore seems that the Entomostracan life is undergoing great changes, which will offer good field for investigation. It seems peculiar that such complete changes should be made in the waters of a lake of this size as indicated by this comparison.

The absence of *Daphnia pulex* from Flathead Lake, and its abundance in Daphnia Pond, which is but a few rods from the lake, suggests either that this species does not like cold

water, or else that it is preyed upon by fish. Since it is common in Yellowstone Lake, neither of these explanations would be satisfactory. The absence of *Daphnia pulex* and the great abundance of *Cyclops pulchellus*, as noted, need explanation.

McDonald Lake of the Mission Mountains lies at the foot of McDonald Peak on the northwest. It is about eleven miles from St. Ignatius Mission, and about fifteen miles due north of Sin-yale-a-min Lake. Sin-yale-a-min Lake is at the foot of Sin-yale-a-min Mountain, the last on the range south next the Jocko River, which river cuts the range in two. McDonald Lake, like Sin-yale-a-min Lake, is hemmed in on all sides except the west by mountains, but at McDonald the mountains are tall, rugged, and very picturesque. The lake was named back in the sixties, and, according to priority, the name McDonald should easily displace the same name given to Terry Lake, above Kalispel.

McDonald Lake is a beautiful spot. Seldom will one find such a combination of grand mountain peaks with the quiet serenity of the water. The sun sinking in the west at the close of the long days of summer gilds the peaks with tints of surpassing beauty. Campers on the banks of the lake have seen goats on the crags above, though at present they are comparatively scarce so close to the haunts becoming frequented by man. The banks of this lake have been a resort for the Indians and white men of the region for many years. There is but a small place at the western end where camping is possible, and the banks for the remainder are abrupt, steep, and rocky, but the small grassy spot, with the peaks in the immediate foreground, is a place frequented often. Of course the usual stories are told about the great depth of the lake, and up to the time of our visit no one had any idea of the real depth, but it was said to be "bottomless."

The valley enclosed by the peaks, in which the lake now is, has been carved out by a glacier, the remnant of which yet exists on the slopes of the peak in plain sight from almost any place on the lake. The rocks along the sides have been ground smooth, and show plainly the marks of the ice. At the outlet of the canon a large moraine has been made. The water in times past has evidently been much deeper than at present, and at the upper end what is now a wooded valley was covered with water and was a part of the lake.

The lake is about a mile and a quarter long, with an average width of less than a quarter of a mile. On either side the mountains come abruptly to the water, as may be seen by the illustration. At the upper end there is an unexplored small valley, abundantly wooded with large arbor vita trees and with fir, birch, and small trees of other species. The inlet divides above the lake, one branch receiving the water from the glacier visible, the other bringing the water from the amphitheatre toward the east, and has for drainage not only the peaks visible, but also the eastern slope of McDonald Peak. (Pl. XIV.)

The bottom of the lake slopes gently (Pl. XV), showing that the lake has apparently filled up a great deal. The depth from end to end is nearly uniform, the greatest being sixty-eight feet. The lower end is shallow, the outlet being crossed by a ford, hub deep at the time of the examination, late in July. There is considerable shallow water, and the bottom is of mud of a reddish color, apparently from the decomposition of the soft rock on the north. At a point near the middle a ledge of rocks projects from either side, making the lake at this point quite narrow. The rocks are precipitous, and the water a few feet from the rocks is deep. These rocks are worn smooth by glaciation, and show deep and numerous glacial scratches.

On the north, to the left in the illustration, the rocks are precipitous for about 2,000 feet. Four waterfalls, with small streams, tumble over the rocks, the water disappearing in the loose talus at the base long before it reaches the lake. The southern slope is not so abrupt, large masses of loose talus, with large boulders, lining the water's edge, making a loose and spongy surface for the retention of moisture.

Life in and around the lake is not abundant. Frogs and snakes are practically absent, but one of the former being seen, none of the latter. On the rocks at the water's edge, altitude 3,300 feet, several pika, *Lagomys princeps*, were killed. This is the lowest altitude known to the writer at which these peculiar mammals have been killed. The banks are so steep and rough that it is all but impossible to climb along, almost an entire afternoon being spent in getting from one end to the other, a few hundred feet from the water's edge. If explored it is very likely the upper end will show a possibility of greatly increasing the surface by increasing the depth.

On the northern side the timber is not so dense, owing to the nature of the rocks, which are steep and allow poor foothold for timber. On the mountain above the precipitous rocks the timber is quite heavy, largely of yellow pine and fir. The southern bank is well wooded, and the canyon at the head of the lake is densely wooded, through which there does not appear to be an entrance made by road or trail. At the outlet and along the moraine near the lake there is fine timber, some of which has been cut for rails and lumber. Everywhere there is much underbrush, making progress difficult.

The road to the lake is good, and there is considerable travel over it in the summer time, as the lake is a great resort for the Indians and others, who visit the reservation on account of the excellent fishing and beautiful scenery. There is no drift around the shores, most of the drift having lodged in the outlet where there is quite a jam.

An ascent of the mountain, and conversation with men from the United States Geological Survey has given a comprehensive idea of the drainage system. The upper slopes of the mountains are bare. Most of them have been partially covered on the higher surfaces with black pine, which has been killed off by fire.

McDonald Peak is double, the western peak being perhaps a thousand feet lower than the eastern. The two are connected by a ridge with a depression in its middle. To pass from the western peak to the eastern is to descend over rock for a thousand feet, then up about two thousand. The western peak is easy of ascent, the last fifteen hundred feet requiring about four and a half hours, however. But to ascend the high summit from this peak appears difficult, though by taking the snow it is no doubt possible. So far the main peak has not been ascended from the west.*

The main peak has three or four spurs projecting in different directions, behind which the snow lies in deep drifts, making ice, and remaining the year through. There is little snow on the western peak, and its importance as a snow holder lies in the fact that it permits the snow blowing from the valley in the west to pile up between it and the main peak, thus making the glacier visible from almost every part of the valley. These spurs make such protection that in

* Since writing the above I am told ascent has been made this way, along the edge of the snow. Three Indians are said to have gone up and returned in safety.

three different places on the heights of this mountain the snow piles in drifts, which never melt, making three large glaciers. One of these, the one seen from the lake, is shown in the illustration, the others lying behind the spurs. The waters from these three snow masses all flow into McDonald Lake. The supply is therefore abundant and never failing. Moreover, the peaks to the north of McDonald Peak, and to the north of the lake, give much of their waters to the lake.

Post Creek, the outlet of the lake, at a point some twelve miles from the lake, lower in altitude by a thousand feet, with considerable loss through irrigation, carried 473 second feet of water on the 30th of June, 1900.

The microscopical life of the lake will no doubt prove interesting when it is worked up, as will be the case of most of these mountain lakes. The collecting net revealed an abundance of *Diaptomus ashlandi*, and the female of another form a little smaller. These were taken August 18, the net being let down to the bottom, 67 feet. *D. ashlandi* was abundant, being quite conspicuous on account of its red color.

The steep and rocky talus along the lake produces a new species of land shell, named by Pilsbry, *Pyramidula elrodi.* Description of this shell is to be found in Nautilus, Vol. XIV., p. 40. About forty were secured, all dead. The dead shells are a beautiful white, their color against the dark brown or lichen colored sandstone making them very conspicuous objects. The shells were scattered among the talus at the base of the cliffs of the mountain, and though they were conspicuous it required considerable effort to secure the few taken. Diligent search failed to reveal live specimens, but later search may serve to find them.*

In the waters of the lake *Limnaea emarginata* Say is quite abundant. It apears to be of a variety distinct from any described, and for it the varietal name *montana* has been suggested. The animals cling to the rocks along the sides and bottom of the lake, seldom found away from the rocks. A few *Physas* were found, but they were scarce. It was surprising not to find a single *Planorbis* in the lake. *Pyramidula strigosa* Gld., var. *cooperi* W. G. B., and *P. solitaria* Say were found abundantly in the damp woods along the lake and creek. It is interesting to note that a large series was secured which had evidently been killed by squirrels, as

*Several dozen have since been found.

each had a hole gnawed in the shell. These shells alive showed very strikingly the idea of protection, as it required the most careful search to find them, and repeatedly they were overlooked by the person in front and seen by the one behind. Their home is in the damp brushy woods, and to secure the series taken resulted in scratched hands and faces and torn clothes, not to speak of the discomfort of crawling among the brush on hands and knees, with the digging among the debris of old logs necessary to find them.

Altogether but five species of shells were found, rather a low number considering the size of the lake and the country.

During the summer of 1900 a stay of ten days is planned for McDonald Lake. It is hoped to find live species of the new shells. Further study of the Entomostraca will be made on the lake, with pumping apparatus. The adjacent country will be searched for birds, and alpine forms collected.

Daphnia Pond, so-called on account of the great numbers of *Daphnia pulex* found in it, is a small pond of some ten to fifteen acres. It is about a mile and a half from the Station, alongside the regular wagon road, and only about a half mile from the lake, but at a little higher altitude. This pond is no doubt of glacial origin, as the entire northern end of the Mission Range has been overrun by glaciers, leaving many evidences behind. In the center the water is about twenty feet deep, but for the most part the pond is shallow and overgrown with rank vegetation, offering an excellent harbor for smaller forms of life. No fish have as yet gotten into this pond, and consequently the invertebrate fauna is not affected by them, and has few enemies. It is a typical place to study some of the forms of life found therein, living as they do under very favorable conditions. The varied and abundant life in this small pond is in strange and striking contrast to the limited quantity and paucity of species in the large lake, so short a distance away.

The most abundant Entomostracan forms were *Diaptomus lintoni* Forbes, described from specimens taken in the lakes and pools of Yellowstone Park, and *Daphnia pulex*, so abundant that the water appeared of a dirty red color. Numbers of half-grown individuals were found with the adults. In the open water they were taken by the tablespoonful with an ordinary insect net. Nowhere have I ever seen anything so abundant as *Daphnia pulex* in Daphnia Pond. Swimming

among the pond lilies, and keeping out of the open water might be seen a large species of *Gammarus*, an inch in length when expanded. A few *Cyclops pulchellus* were found among the more abundant species.

Shells are numerous in specimens though not in species *Planorbis trivolvis* Say is the most abundant. This widely distributed species was taken in all sizes from small to fully grown. *Sphaerium partumenium* Say was found among the dense vegetation, and was taken in considerable quantity. *Physa ampullacea* Gld. (possibly *heterostropha* Say) was not uncommon. Along the banks of the large lake the land form, *Pyramidula strigosa* Gld., var. *cooperi* W. G. B., was found. At the lower end of Flathead Lake, in the fine sand along the river bank, were found *Planorbis parva* Say, while in the sands of the lake were fragments of the bivalve, *Margaritana margaritifera* L.

In insects there is likewise great abundance in Daphnia Pond. Dragon-flies were noted most especially. The first week in August, 1899, *Aeschna constricta* Say was exceedingly abundant. Hundreds were flying in the air, and wherever Odonata were found flying mosquitoes were rare. The exuviae of this species were taken in quantity from the rushes, cattails, tall grass and weeds. The exuviae had the characteristic living attitude, the feet firmly clasping the stalk of the plant. They were usually found a foot or two above the water, but it was not uncommon to find them even three or four feet above water, the insect having crawled this distance before transforming into the adult. Only a few larvae could be found, showing that the transformation was practically completed at this date for the species.

The next largest was *Libellula pulchella* Drury. These were also on the wing in numbers the first week in August.

During the last two weeks in July *Lestes unguiculata* Hag. were emerging in great numbers. They are at first very feeble on the wing, lacking in color, with soft flabby bodies. While no birds were actually seen eating dragon-flies the presence of many king-birds, *Tyrannus tyrannus*, was a pretty good indication that these birds were seeking such insects for food.

Other dragon-flies taken are as follows: A few *Lestes disjuncta* were taken. *Enallagma calverti* Morse was on the wing in the middle of July in abundance. *Enallagma prae-*

varum Hag. was taken, thus extending the distribution of this species. It is now reported only from Louisiana, Kansas, and Montana. *Sympetrum scotica* Donov. was rather abundant, as also *Sympetrum rubicundula* Say, var. *assimilata* Uhler. Many larvae of different species were taken, but all have not as yet been determined.

Case-worms were found in considerable abundance. One species builds the cases out of leaves and the stalks of the green vegetation. Leeches, water-beetles, dipterous larvae, water-bugs, and worms add to the list collected and yet unworked.

Daphnia Pond is near the field laboratory, and presents good opportunity for work. Farther along the road is a second pond, which will present as good a field. Neither of these contains fish, and both teem with life in the summer time.

The region near Kalispel has many lakes awaiting study. Swan Lake, about eight miles from the Station, has been unworked save for a few hauls made by Forbes. Following up the river which enters Swan Lake to the divide and down the Clearwater and the Big Blackfoot to Missoula, a distance of a hundred and twenty-five miles, one passes a dozen to fifteen lakes of different sizes which have been as yet untouched. The northern end of the state has Terry or McDonald Lake and St. Mary's Lake, both of good size, and neither of which has been worked. The opportunities offered for work in Montana are great, but difficulties and distances are also great. As but a small portion of the time during the summer of 1889 could be devoted to this work, and during this time many pressing things engaged the attention, it is not surprising if there is much disappointment at the comparatively meager results. But the way is opened, the field partially disclosed, and a trail cut through the apparently impassable wilderness. Each succeeding pack train will make the trail plainer and meanwhile the facilities for taking the train in and getting material out will be better. Moreover, it is hoped the numbers composing the pack trains will increase. More than any other one thing the naturalist working in Montana needs kindred spirits to rub up against for mutual aid, to brush away the cobwebs that accumulate, and to ask stimulating and difficult questions, even though the answers may require years of work. More work, and more valuable work, will be done in succeeding years.

EXPLANATION OF PLATES

Plate X

Mouth of Swan River, and Flathead Lake. In the distance, to the right, about three miles off, may be seen the bar at the mouth of Flathead River. Cabinet Mountains in the distance. View is southwest.

Plate XI

A bit of beach at Flathead Lake, showing characteristic shore, vegetation, and drift.

Plate XII

A

Lower end of Flathead Lake, from summit of moraine, showing islands in the distance. In the foreground to the left is the outlet of the Pend d'Oreille River. The islands are about seven miles out from the shore. The view is north.—Photograph by Chas. Emsley.

B

Mission Mountains, from Crow Creek, after a storm. The high peak in the center is McDonald. The view is almost directly due east. The distance is about eighteen or twenty miles.

Plate XIII

Rapids in the Pend d'Oreille River, near the lake outlet, Flathead Indian Reservation. View is northwest.—From Photograph by M. J. Elrod.

Plate XIV

McDonald Lake, Mission Mountains, Montana, from the outlet. McDonald Peak is on the right. On the left bank in the picture was found the new shell *Pyramidula elrodi* Pils. View is east.

Plate XV

Outline map of Lake McDonald, showing contour, lines of depth, and geological features referred to in text.

Plate XVI

Canvas boat and plankton outfit of Montana Biological Station at Swan Lake, Montana, August, 1900. At the outlet of the lake looking into Swan River. Swan Mountains in the distance to the right.

Plate XVII

Launch Missoula and rowboat Culex of the University of Montana Biological Station in Swan River harbor, Flathead Lake. Plankton equipment, net, pump, hose, reel, etc., on the shore nearby.

PLATE X

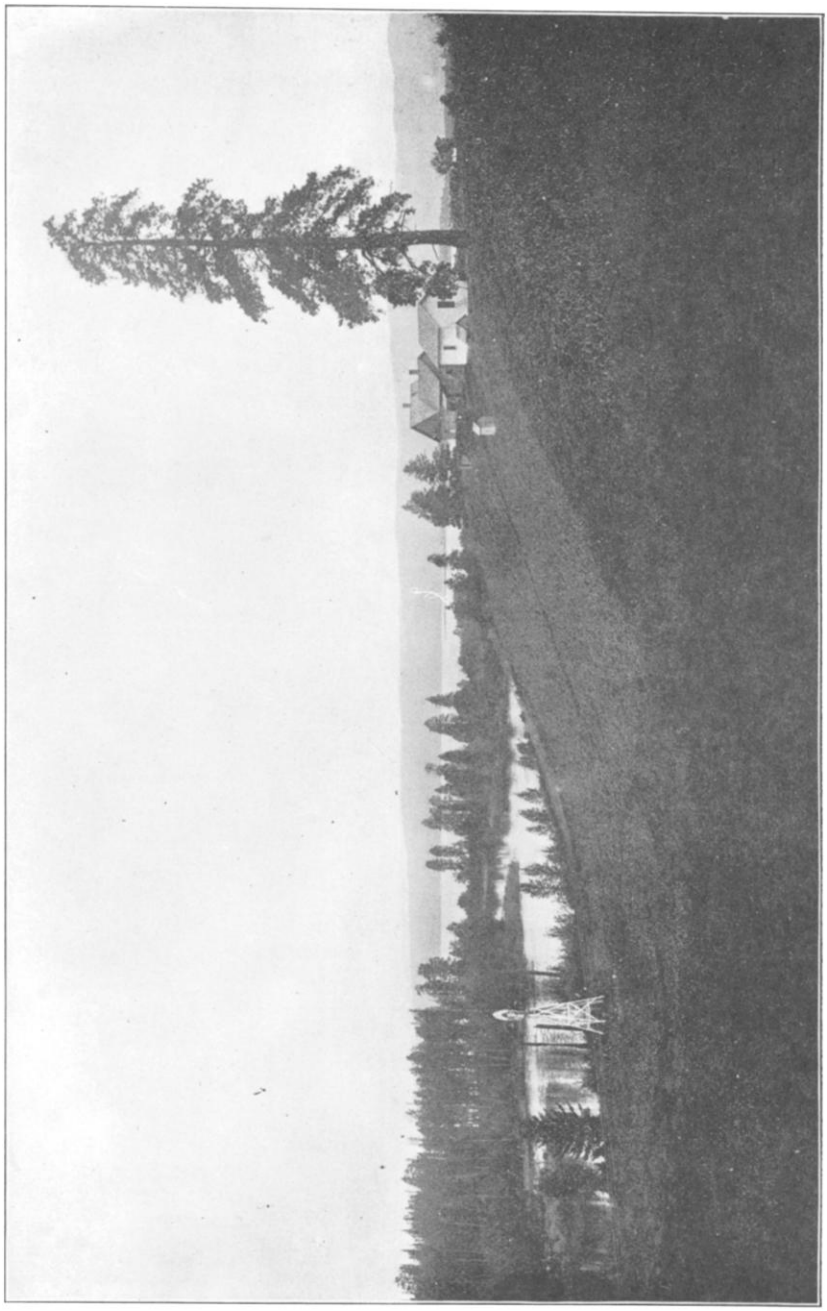


PLATE XI

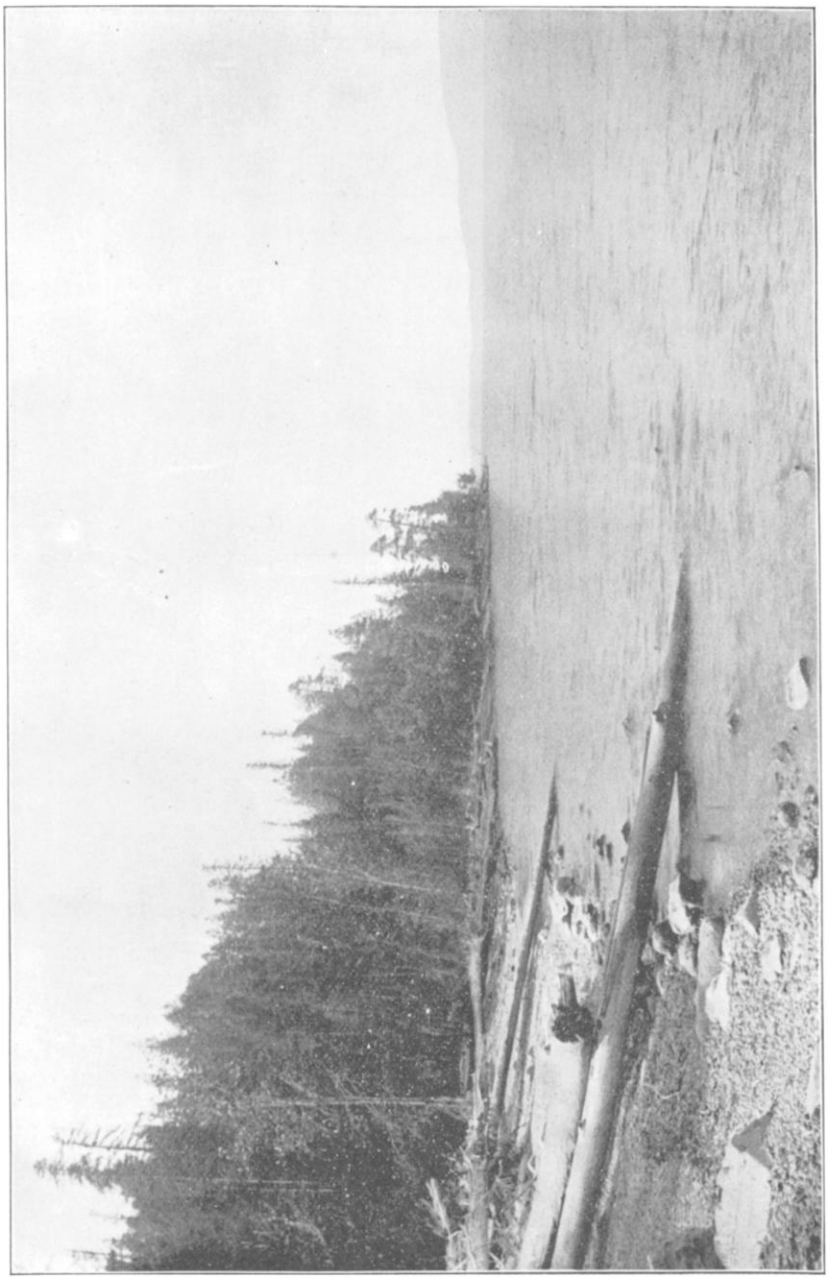


PLATE XII

A

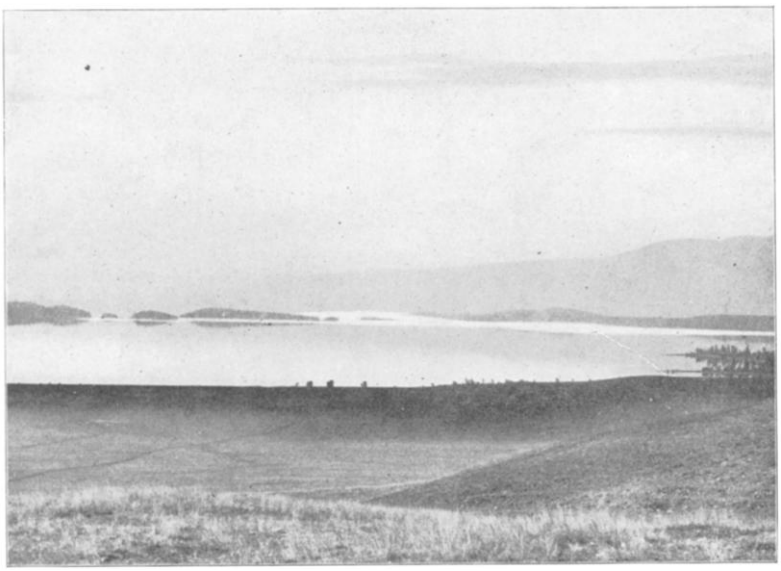


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PLATE XIII

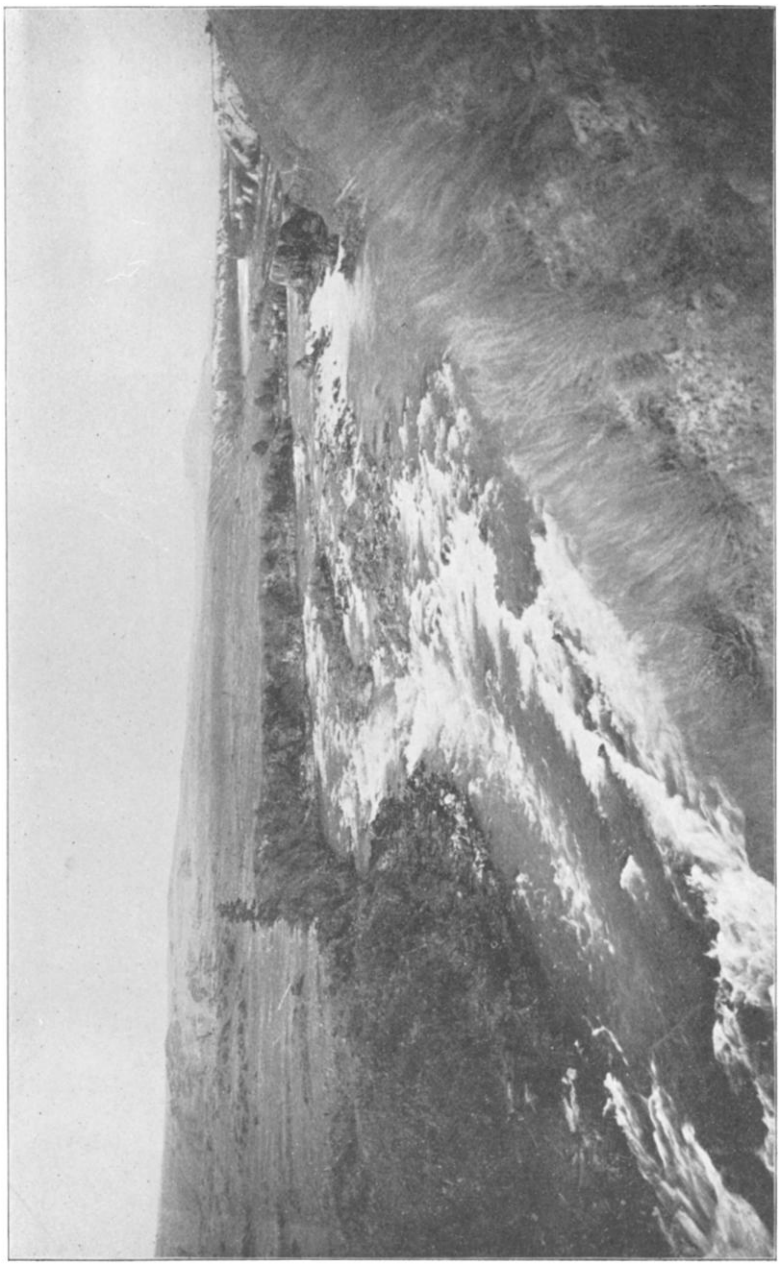

PLATE XIV

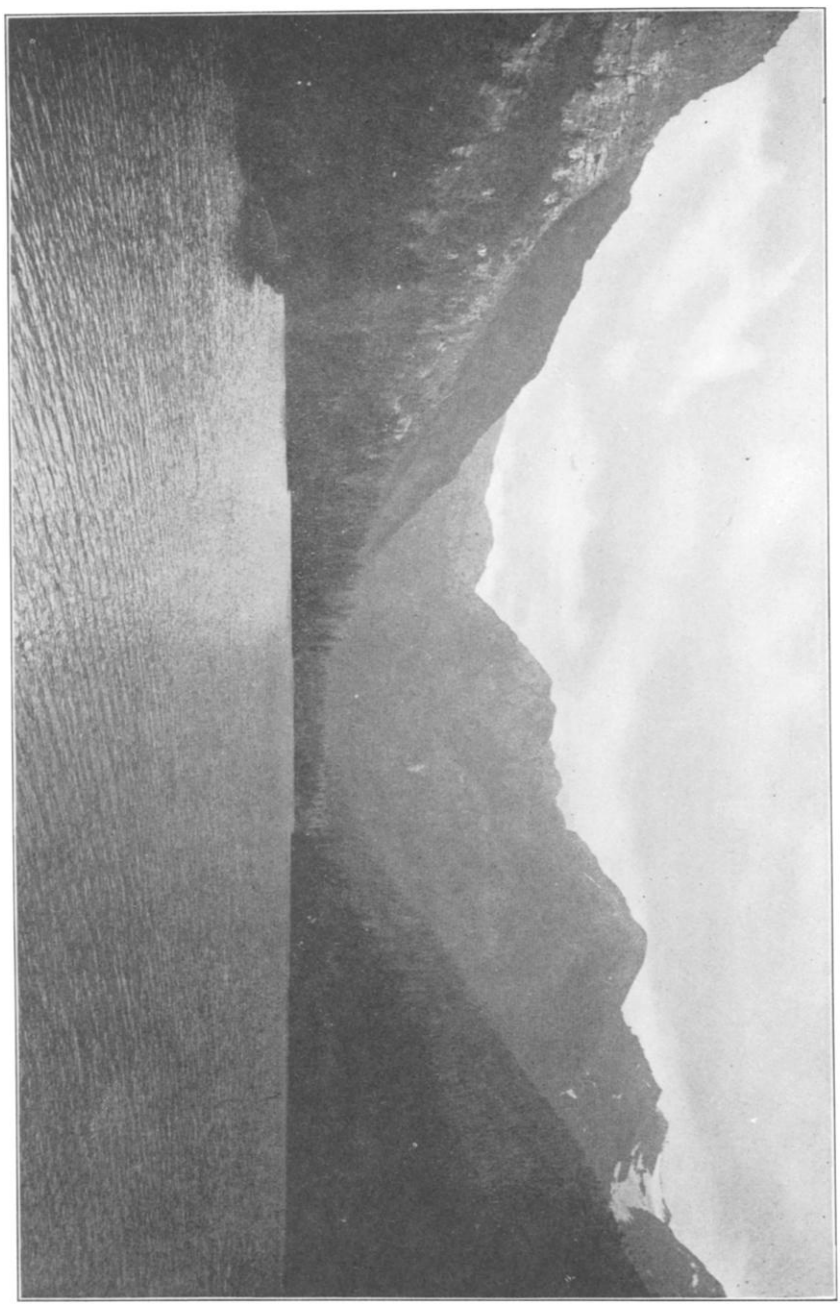

PLATE XV

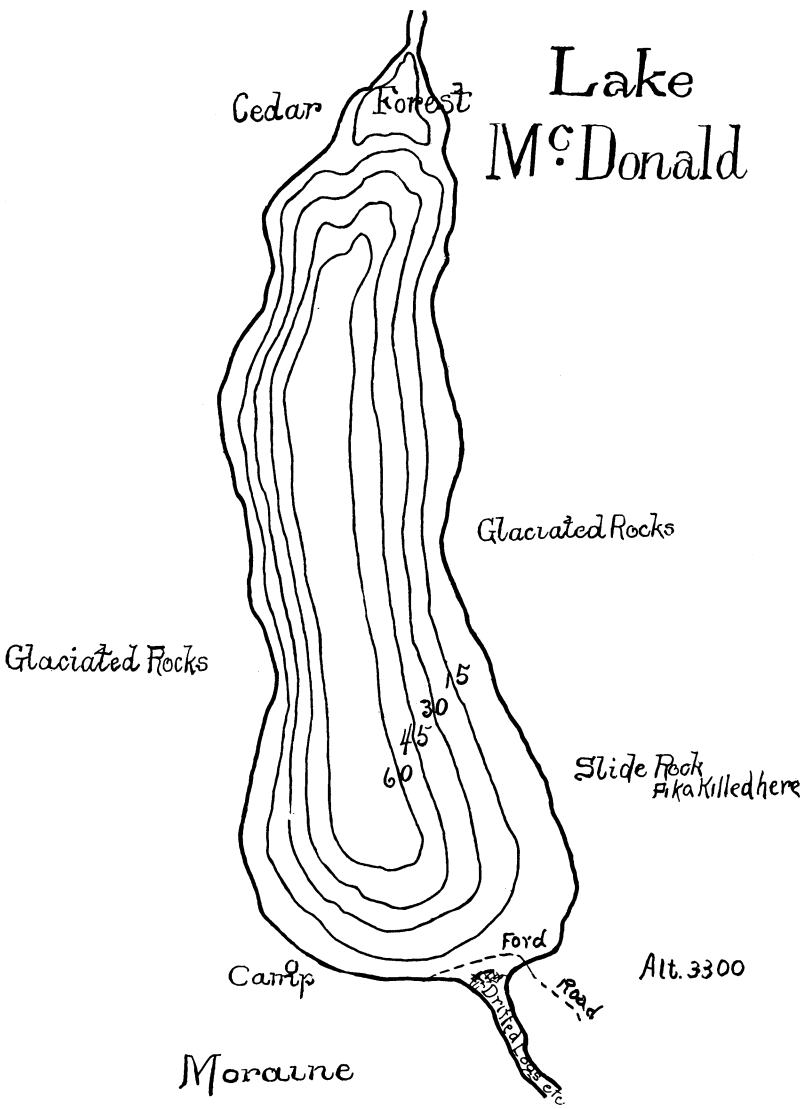
Lake
Mc Donald
Cedar
Forest
Glaciated Rocks
Glaciated Rocks
15
30
45
60
Slide Rock
Fika Killed here
Ford
Camp
Alt. 3300
Road
Drift at base etc.
Moraine

PLATE XVI

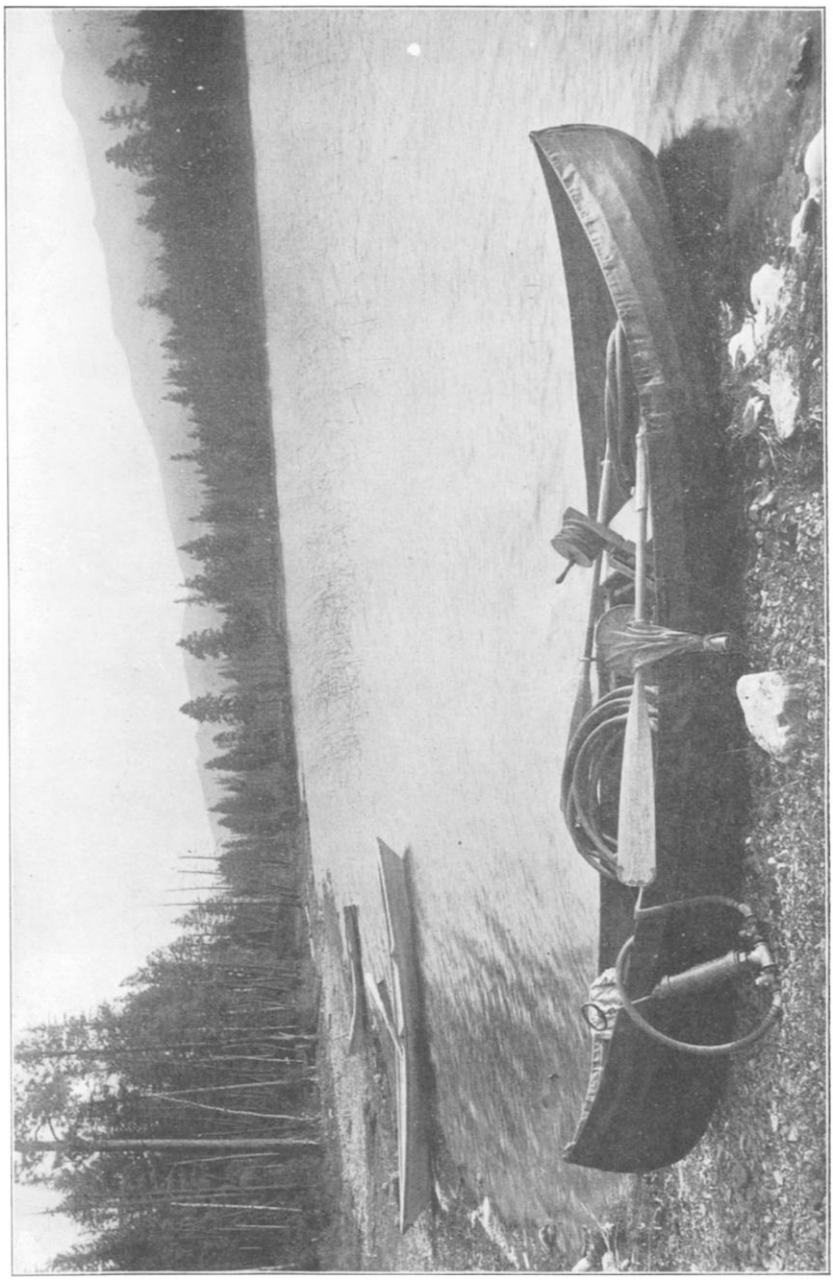

PLATE XVII